Reid and Wells on Single and Double Vision

Giovanni B. Grandi

In a recent article on Reid's theory of single and double vision, James Van Cleve considers an argument against direct realism formulated by Hume.[1] In the *Treatise of Human Nature*, Hume argues for the mind-dependent nature of the objects of our perception from the phenomenon of double vision. As Hume says, '[w]hen we press one eye with a finger, we immediately perceive all the objects to become double, and one half of them to be remov'd from their common and natural position.'[2] Since we cannot ascribe continued existence to either of these objects, they must both be mind-dependent. Reid does not address this particular argument, but Van Cleve considers possible answers Reid might have given to Hume. He finds some fault with all the answers he considers.

In what follows, I will first present Van Cleve's reconstruction of Hume's argument. I will then suggest that both appearances in double vision could be considered visible figures of the object, and show how this solution might preserve Reid's direct realism. However, this solution is not compatible with the single appearance of an object predicted by Reid's theory of single and double vision. This consequence will appear evident, once we consider the critique of Reid's theory of single and double vision formulated by William Charles Wells (1757–1817) in his *Essay upon Single Vision with Two Eyes* (1792).[3]

Hume's Argument

According to Reid's *Inquiry*, double appearances occur as a result of shifting attention to an object on which our eyes do not converge. If we attend to a finger closer to us than a candle on which our eyes converge, the finger will

[1] James Van Cleve, 'Reid on Single and Double Vision: Mechanics and Morals', *Journal of Scottish Philosophy* 6 (2008), 1–20.

[2] David Hume, *A Treatise of Human Nature*, edited by David Fate Norton and Mary J. Norton (Oxford, 2000), I.iv.2, 140.

[3] Reid briefly reviewed Wells' *Essay upon Single Vision with Two Eyes* (Aberdeen University Library, Birkwood Collection, MS 2131/3/I/4): see Appendix II.

appear double. If we attend to a candle situated further away from us than a finger on which our eyes converge, the candle will appear double.[4] These double appearances do not last long, since our eyes follow the direction of our attention and converge on the object that we attend to.[5] But the argument to be drawn from this experiment is the same as in the case of double vision presented by Hume. In the systematization of Van Cleve, when you attend to your finger while focusing on the candle:

1. You see two fingery objects.
2. There are not two (existent) physical fingers before you. Therefore,
3. a. You see at least one fingery thing that is not an (existent) physical finger. b. It is a mental finger – a fingery image or sense datum existing in your mind.
4. The other fingery object you see is (as Hume says) 'of the same nature' as the mental finger (i.e., is phenomenologically just like it). Indeed, every finger you have ever seen is of the same nature as the mental finger.
5. Items that are phenomenologically alike have the same ontological status. (Ontology recapitulates phenomenology, to echo an old slogan.) Therefore,
6. Every finger you have ever seen has been a merely mental finger. Generalizing: you have never seen any objects in the physical world but only mental images of them.[6]

Van Cleve examines how each of the five premises could be denied. I won't discuss Van Cleve's observations on premises 4 and 5. Premise (3b) says that at least one of the two fingery objects exists only in your mind. This premise follows from the premise (3a), according to which, at least one of the two fingery

[4] Thomas Reid, *An Inquiry into the Human Mind on the Principles of Common Sense*, edited by Derek R. Brookes (Edinburgh, 1997), VI.13, 133/35–134/10.

[5] Ibid., 134/15–135/23.

[6] Van Cleve, 'Reid on Single and Double Vision', 11. Van Cleve's reformulation of Hume's argument is debatable, as John P. Wright has pointed out to me. For Hume, the immediate conclusion of the argument is that 'all our perceptions are dependent on our organs, and the disposition of our nerves and animal spirits' (Hume, *A Treatise of Human Nature*, I.iv.2, 140). The dependence of perceptions is a dependence on the state of our bodies – or more precisely on the mind/body union. Thus, the contrast between what is 'mental' and what is 'physical' would not really capture Hume's discussion of double appearances. His final conclusion in the paragraph is merely about the lack of independence of our sensory perceptions.

things is not an existent physical object. In its turn, this premise follows from premise 2, which says there are not two existing physical fingers before you.

Van Cleve: Double Appearances Cannot Be Visible Figures

As we have seen, premise (3b) says that at least one of the two fingery objects exists only in your mind. New Realists – as Van Cleve calls them – deny this premise. In their view, '*both* of the fingery objects you see are externally existing physical and finger-like objects, even if at most one of them is (or is part of) a flesh and blood finger'.[7] If this account is correct, you still don't have any guarantee of perceiving an object directly in a case of double vision, but at least you directly perceive two other external physical objects that represent the original object.

Van Cleve adds that '*at most* one of [the fingery objects] is (or is part of) a flesh and blood finger'.[8] It may not be clear why they can't both be parts of the same flesh and blood finger. Given that objects have different parts, why can't both the fingery objects we see be parts of the original flesh and blood finger? Presumably, Van Cleve just extends to both fingery objects, conceived merely as parts of the blood and flesh finger, what can only be said of the fingery objects conceived as distinct physical objects. No two distinct physical objects can exist in the same place at the same time, and no two parts of a numerically identical object can exist in the very same place at the same time. However, these principles do not prevent two distinct parts of a numerically identical object to exist in different places at the same time. But it would appear an impossible task to show that the two fingery objects I see in the case of double vision are both parts of the same object. After all, the two fingery objects are not contiguous to each other, and there is not a continuous path from one to the other that remains within the same object. They certainly look to our sight as two distinct things rather than two parts of the same thing.

Perhaps, Reid's notion of visible figure could be put to use to explain how both fingery objects could be parts of the same blood and flesh finger. Van Cleve is aware of this possibility, and he explains why it can't work. He first introduces the distinction between real and visible figure of an object. In Reid's words:

---

[7] Ibid., 13.

[8] Ibid. Emphasis added.

> [A]s the real figure of a body consists in the situation of its several parts with regard to one another, so its visible figure consists in the position of its several parts with regard to the eye.[9]

An example of visible figure mentioned by Reid is the elliptical shape of a round plate viewed obliquely.[10] As Van Cleve says, Reid explicitly denies that visible figure is a mental item (an impression or an idea), since it is extended in breadth and length and no mental item can be extended and figured. Therefore, visible figure is real and external to the eye.[11] These claims are sufficient for making visible figure a suitable candidate for explaining the two appearances in double vision. As Van Cleve says: 'Perhaps, then, Reid would say that when you see double, what you see are two visible figures, both of them existing in the space external to the eye'.[12]

Van Cleve then applies to double appearances conceived as visible figures, the following dilemma: either (1) the two visible figures of the finger are external objects numerically distinct from the finger itself, or (2) they are parts of the surfaces of the finger. As Van Cleve argues, if they are numerically distinct from the finger itself, then Reid's direct realism is compromised, since we perceive an object only by perceiving something else that is not even part of it. We are bound to accept this consequence, if we want to consider double appearances as visible figures, since, according to Van Cleve, the second horn of the dilemma is not true: visible figures are not parts of the surfaces of things we perceive by sight.

> A possible development of this position would be that visible figures are generally (though not always) parts of the surfaces of physical things like fingers and tables, and that one can see a finger in virtue of seeing its facing surface or some part of it. For better or for worse, however, Reid's views about the geometry of the visual field make this strategy unavailable to him. Reid believes that the familiar geometry of Euclid holds for tangible figures, but not for visible figures; for example, the tangible surface of a rectangular tabletop has an angle sum of 360 degrees, but any visible rectangle will have an angle sum greater

[9] Reid, *Inquiry*, cit., VI.7, 96/27–30.

[10] Ibid., VI.7, 95/20.

[11] See the passages from the *Inquiry* mentioned by Van Cleve: Reid, *Inquiry*, cit., VI.8, p. 98/27–30, and p. 101/25.

[12] Van Cleve, 'Reid on Single and Double Vision', 13.

> than 360 degrees. It follows that what I see when I look at my tabletop cannot be part of its surface.[13]

Van Cleve's reasoning is compelling: the geometry of visible figures is different from the geometry of the (parts of the) surfaces of objects; therefore visible figures cannot be parts of the surfaces of objects.

Reply to Van Cleve: Double Appearances Can Be Visible Figures

We should reject Van Cleve's dilemma. It is not true that visible figures in double vision must be either two objects distinct from the real object or two parts of the surface of the object. In perceiving two visible figures we directly perceive the very same object but from two different points of view. Therefore, we see it differently since the object has different properties in relation to these different points of view.

As we have seen, visible figure is determined by the position of the parts of an object with regard to the eye. We originally perceive the visible figure of an object by sight, but we do not perceive the object's distance. An object that is further away from us will subtend a smaller angle at the eye than the same object close by: as a consequence, its visible figure will occupy a smaller portion of the visual field in the former case than in the latter case, although the object remains the same in its tangible properties. In a similar manner, it is not surprising that the sum of the angles of a square tabletop should be more than 360 degree in relation to the point in space where the eye is located, and that this angle sum varies in relation to the point of view. We are speaking indeed of different properties of the same object: the position that the parts of the object have in relation to each other is ascertained by the sense touch, while the position that the object has in relation to a point in space where the eye is located is ascertained by the sense of sight. While the first is an intrinsic property, the latter is relative to a viewpoint but is nevertheless real and reliably ascertained by the sense of sight. Indeed, in another paper, Van Cleve claims that visible figure is a relativized property of an object, a property that an object has in relation to the place where the eye is situated.[14]

---

[13] Ibid.

[14] James Van Cleve, 'Thomas Reid's Geometry of Visibles', *Philosophical Review* 111 (2002), 373–416.

Hence, in seeing the visible figure of an object, we directly perceive the very same object we touch, but only partially, that is, only insofar as its parts have position with regard to the eye. That direct realism is not compromised by visible figure is confirmed by Reid's analysis of straight lines in the *Inquiry*. In the *Inquiry*, he compares the notion of a straight line that a purely visual observer has with our notion of a tangible straight line. In perceiving a line as straight, a purely visual observer excludes curvature to the right and left sides, but cannot exclude curvature backward and forward, since he is not aware of a third dimension. However, his perception of the line is correct as far as it reaches.[15] This analysis is confirmed in the *Essays*, where Reid calls visible space a partial notion of tangible space, and is explicit in denying that visible and tangible space are two different things:

> [W]hen I use the names of tangible and visible space, I do not mean to adopt Bishop BERKELEY's opinion, so far as to think they are really different things, and altogether unlike. I take them to be different conceptions of the same thing; the one very partial, and the other more complete; but both distinct and just, as far as they reach.[16]

In order to appreciate Van Cleve's point, one should go back to his original article.[17] There, he argues that a genuine non-Euclidean geometry must be a geometry of entities that possess non-Euclidean properties intrinsically. But the objects we directly perceive by sight do not have non-Euclidean properties intrinsically, but merely in relation to the point where the eye is located. Therefore – as van Cleve argues – either (1) we give up the claim that Reid discovered a genuine non-Euclidean geometry, or (2) we give up direct realism and introduce non-Euclidean visible entities as proxies for the real object. I will not examine this further dilemma here: I only point out that it arises from Van Cleve's notion of what constitutes a 'genuine non-Euclidean geometry'. He claims that a genuine non-Euclidean geometry is a geometry of objects that have non-Euclidean properties intrinsically, but this is a highly debatable assumption.[18] It is enough for the purpose of this paper to grant

[15] See Reid, *Inquiry*, VI.9, 106/23–108/24.

[16] Thomas Reid, *Essays on the Intellectual Powers of Man*, edited by Derek R. Brookes and Knud Haakonssen (Edinburgh, 2002), II.19, 222/37–223/2.

[17] See above, note 14.

[18] On this question, see Giovanni B. Grandi, 'Reid's Direct Realism about Vision', *History of Philosophy Quarterly* 23 (2006), 225–41.

that three-dimensional Euclidean objects have non-Euclidean features merely as relativized properties.

Visible Figure, Visible Position, and the Law of Visual Direction

According to Reid, visible figure consists in the position of the parts of an object with regard to the eye. By sight we do not directly perceive its distance, but we do directly perceive its visible figure. In different words, we directly perceive the position of the parts of an object with regard to the eye (with the added qualification that, in normal conditions, we only perceive the position of those parts that are facing our eye: these normally reflect light to the eye). That, by sight, in normal conditions, we directly perceive the position of the parts of an object with regard to the eye seems to be a consequence of a law of vision on the direction we see points of the facing surface of an object: '[E]very point of the object is seen in the direction of a right line passing from the picture of that point on the *retina* through the centre of the eye'.[19] In normal conditions, the rays of light sent to the eye from a point of an object are collected by refraction of the crystalline in one point on the retina. Because of the abovementioned law, the point of an object will then be seen in the direction of a straight line passing from the picture of that point on the retina through the centre of the eye. Explaining the notion of position with regard to the eye, which is central to the notion of visible figure, Reid says that

> Objects that lie in the same right line drawn from the centre of the eye, have the same position, however different their distances from the eye may be: but objects which lie in different right lines drawn from the eye's centre have a different position.[20]

We may want to speak of different points on the surface of the same object rather than of different objects. Thus, we can reformulate Reid's thought: different points will have different positions with regard to the eye if and only if they lie on different right lines drawn from the centre of the eye. Reid must have thought that his account of visible figure given in Chapter 6, Section 7, of the *Inquiry*, is compatible with the law of visual direction given in Chapter

[19] Reid, *Inquiry*, VI.12, 122/39–123/2.
[20] Ibid., VI.7, 96/20–24.

6, Section 12. Hence, he must have assumed that the right line that determines the position of a point of an object with regard to the eye must be coincident with the direction in which we see this point. In other words, the line drawn from the centre of the eye to a point of an object must be coincident with the line passing from the image of this point on the retina through the centre of the eye.[21]

The Problem: Is the Law of Visual Direction Compatible with the Law of Single and Double Vision?

The notion of visible figure depends on the notion of visible position of the parts of an object with regard to the eye. We can further assume that this notion of visible position must be compatible with the law of visual direction enunciated by Reid. If we see an object in the direction of a right line passing from the point on the retina where its image fall through the centre of the eye, we see the position of the object with regard to the eye.

Two questions emerge from this analysis of the relation between visible figure, visible position, and visual direction:

First, Reid must have thought that the law of single and double vision is compatible with the law of visual direction. We must then determine whether his account of single and double vision is really compatible with the

[21] There is a certain degree of ambiguity in speaking of 'the direction in which we see an object'. Among the possible meanings are the following ones: (1) In monocular vision, an object *a* is seen in the same visible direction (or has the same visible position) as another object *b*, when both objects *a* and *b* are seen on the same right line passing from the point where their image fall (or would fall) on the retina through the centre of the eye (or, which is the same, when both objects are on the same right line drawn from the centre of the eye to them). Two objects *a* and *b* are seen in two different visible directions when they are seen on different lines passing from the point where their image falls on the retina through the centre of the eye (or, which is the same, when they are on different right lines drawn from the centre of the eye to them). (2) In binocular vision, we often speak of 'an object to which both our eyes are directed' or 'an object on which the axes of both our eyes are directed' (for example, the candle and the finger of Reid's example). From this expression, we may perhaps go on to say that we see one object in the 'same direction' with (or by) both our eyes, when both our eyes are directed at the same object, that is, when the optic axes of both eyes converge on the object. If we accept this sense of 'same direction', an object on which both optic axes converge is seen in the same direction by both eyes. An object on which the two optic axes do not converge is not seen in the same direction.

law of visual direction. We will see that, according to William Charles Wells (1757–1817), Reid's account of single and double vision is compatible with the law of visual direction, but only at the cost of being incompatible with another fundamental claim of Reid's theory of vision, the claim that we do not immediately perceive distance by sight.[22]

Secondly, the double appearance of a light-radiating point on the surface of the object can also be the result of this point projecting two images on the retina of the very same eye. Since this point projects two images on the retina, we see it in two different lines passing from its two images on the retina through the centre of the eye.[23] But, clearly, double vision with one eye cannot explain double vision with two eyes. In the case of double vision with two eyes, we see one appearance with one eye, and another appearance with the other eye. One could then explain this double appearance by saying that we see the object from one point of view, and so in one line of visible direction, with one eye, and from another point of view, in another line of visible direction, with the other eye. But given that we see an object from two different points of view even when our eyes do converge on an object, that is, when we do perceive an object as single, then one may ask: why

[22] William Charles Wells, *An Essay upon Single Vision with Two Eyes: Together with Experiments and Observations on Several Other Subjects in Optics* (London, 1792), reprinted in Nicholas J. Wade, *Destined for Distinguished Oblivion: The Scientific Vision of William Charles Wells (1757–1817)*, (New York, 2003). The critique of Reid is on pages 79–84 [18–34, in the pagination of the original edition of Wells' *Essay*], and 86–87 [40–2]. William Charles Wells was born in Charlestown, South Carolina, on 24 May 1757, the second son of Scottish settlers. His father was a printer and bookseller in Charlestown. Wells went to school in Dumfries, Scotland, in 1768, and later moved to Edinburgh to pursue a medical degree. He eventually graduated from the University of Edinburgh in 1780. After some time spent in South Carolina and Florida, Wells, who had loyalist sympathies, moved to London in 1784. He worked there as a physician. In 1792, he published *An Essay upon Single Vision with Two Eyes*. He was elected Fellow of the Royal Society in 1793, and became a fellow of the Royal Society of Edinburgh in 1814. Wells published widely on various scientific subjects. He was highly regarded for his *Essay on Dew* (1814). Wells' *Account of a Female of the White Race of Mankind, Part of whose Skin Resembles that of a Negro* (first presented to the Royal Society in 1813 and published in 1818) was brought to the attention of Charles Darwin after the publication of the *Origin of the Species* (1859). Darwin acknowledged Wells' discussion of natural selection in the *Account* in later editions of the *Origin of the Species*. Wells died on 18 September 1817. For an in-depth account of Wells' life and works, see Wade, *Destined for Distinguished Oblivion*; see also Nicholas J. Wade, Hiroshi Ono, Alistair P. Mapp, Linda Lillakas, 'The Singular Vision of William Charles Wells (1757–1817)', *Journal of the History of the Neurosciences*, 20 (2011), 1–15.

[23] This is a point made by James J. S. Foster, 'Reid's Response to Hume on Double Vision', *Journal of Scottish Philosophy* 6 (2008), 189–94.

does the object not appear as double even when, as a matter of fact, we do see it as single? We see an object in two lines of visible direction, drawn from the centres of the eyes to the object, when our eyes are misaligned and do not converge on the same object. But, in the same manner, we see the same object in two lines of visible direction drawn from the centres of the eyes to the object, when our eyes converge on the object: why are we not perceiving two visible figures even when our eyes are converging on an object?

Reid's Theory of Single and Double Vision

Before I explain Wells' criticism, it will be best to recall the detail of Reid's theory of single and double vision.

Reid calls corresponding points those pairs of points of the two retinas that make us see an object single when images of the object are formed on these points. Those points of the two retinas that do not make us see an object as single do not correspond. He further determines that when we converge our eyes on an object, images fall on the two centres of the retinas, and we see the object as single. Hence, the two centres of the retinas are corresponding, that is, they make us see objects as single. According to Reid, we also perceive as single any object on the right or left side that is situated at the same distance from the eyes as the object to which the axes of our eyes are directed. The images of an object at the same distance as the object on which our eyes converge fall on points of the two retinas that are similarly situated with regard to the centres of the two retinas. Hence, these points are corresponding, they make us see objects as single.[24]

It is a consequence of Reid's theory that objects that are further away or closer to our eyes than the object on which our eyes converge are seen as double, since they project images on points of the two retinas that are not similarly situated with regard to the centres of the retinas.[25]

Moreover, if we place an object in the axis of one eye, and another object in the axis of the other eye, each will project an image on the centre of the retina of the eye by which it is seen. But the centres of the retinas are corresponding points, and so, in this case, we will see the two objects as a single object. Reid reports an experiment where two coins are placed at the end of two long tubes

[24] See Reid, *Inquiry*, VI.13, 133/9–35.

[25] See ibid., 133/36–134/10.

through which we see with both our eyes. The two coins appear as single, overlapping each other.[26]

According to Reid, this property of pairs of points of the retinas that allows us to see objects as single is an original property of the eyes.[27]

Wells' Critique of Reid's Theory of Single and Double Vision

Wells' critique of Reid is rather complex, but I will try to isolate the main line of argument.[28]

Wells presupposes that we can see an object as single with both our eyes, if and only if we see it in one visible place with both our eyes. The notion of visible place has two components: visible distance and visible direction. Hence, a theory of single vision will have to explain 'in what manner the distance and direction, which are perceived by one eye, may coincide with those which are perceived by the other'.[29]

[26] See ibid., 136/15–27.

[27] See ibid., 134/11–14. For Reid's refutation of Robert Smith's empirist view on single vision, see Reid, *Inquiry*, VI.17, 151–6.

[28] Wells criticizes Reid's theory of single and double vision in Part I of his *Essay upon Single Vision with Two Eyes* (see *Essay*, 79–84 [18–33]), but I will concentrate on the criticism that appears later in the book, in Part II, in the context of Wells' presentation of his solution to the problem of single vision (see *Essay*, 85 [36–37] and 86–7 [40–4]). See Appendix I for a summary of Wells' arguments in Part I of the *Essay*.

[29] Wells, *Essay upon Single Vision with Two Eyes*, 84 [35]. In a short remark of his manuscript notes on Wells, Reid shows he had reservations on Wells' account of what it means to see an object as single: "44 He [Wells] takes it for granted that when two objects are seen as one, they must be seen in a certain place, that is at a certain distance as well as in a certain direction" (Aberdeen University Library, Birkwood Collection, MS 2131/3/I/4). However, according to Wells, the perception of distance is not essential to an explanation of single vision with two eyes, as long as we agree that we see objects as single with both eyes by seeing them in one direction only: '[N]o person, I believe, has ever observed, that while an object seemed to one of his eyes at a certain distance, it has appeared to the other to be at a different distance, and from this circumstance alone has been seen double; or, to express the same thing in another way, that while the visible appearance of an object to one eye, covered the visible appearance of the same object to the other eye, the two appearances did not seem entirely to coincide, and make one, but were seen separate by the two eyes. I do not stop to give reason of this fact, which must be plain to those who are acquainted with Bishop Berkeley's theory of visible distance; but proceed to mention that, the difficulty in finding a true and sufficient cause for the union of the two visible places of one or two objects to two eyes, must therefore consist altogether in showing, in what manner the two apparent directions may coincide, consistently with the attending phenomena' (Wells, *Essay upon Single Vision with Two Eyes*, 84–85 [35–36]).

Wells then acknowledges that, according to Reid, we do not immediately perceive distance by sight. Wells also grants that the perception of distance is not essential to an explanation of single vision with two eyes, as long as we agree that we see objects as single with both eyes by seeing them in one direction only. According to Reid, it is by an original property of the points of the two retinas that we see objects as single. Hence, this original property must make us see objects as single by making us see them in one direction only.

Wells then points out facts that are confirmed by Reid's theory of single and double vision: (1) an object that is at the point of intersection of the optic axes will be seen as single, and (2) two objects that are anywhere in the axes of the two eyes will be seen as single.

Let's imagine a situation where two objects are in the axes of the two eyes. According to Reid's theory, they will be seen as single, since they project points on the centres of the two retinas, which are corresponding points. Wells describes an analogous case, where we look at a distant object through two small holes in a card. One hole lets us see the object with the left eye, and the other hole lets us see the object with the right eye. While we see the distant object with both our eyes, the two holes appear as one: 'Every person knows, that, if an object be viewed through two small holes, one applied to each eye, the two holes appear but as one'.[30]

Following the desiderata of Wells' theory, we may now ask the following question: in what unique line of direction will this single appearance of the two holes be with regard to our eyes? Different alternatives may be conjured up as answers to this question.[31] Will the appearance of a single hole be in

[30] Wells, *Essay upon Single Vision with Two Eyes*, 86 [40].

[31] In his theory of single and double vision, Wells argues that the apparently single hole neither appears to be situated along the axis of the right eye only, nor along the axis of the left eye only. It does not even appear along both axes at once, at their point of intersection. It rather appears along the 'common axis', a right line drawn from the point intersection of the optic axes to the midpoint of the line joining the two points of the corneas where the axes enter the eyes (he calls this line 'the visual base'). This is a consequence of Wells' first law of single vision: 'Objects situated in the Optic Axis, do not appear to be in that Line, but in the Common Axis'. Wells' second law states that, 'Objects, situated in the Common Axis, do not appear to be in that Line, but in the Axis of the Eye, by which they are not seen'. Objects situated in the common axis will appear to the left eye as lying along the right eye's axis. They will appear to the right eye as lying along the left eye's axis. A third law encompasses the previous two propositions as particular cases: 'Objects, situated in any Line drawn through the mutual Intersection of the Optic Axes to the Visual Base, do not appear to be in that Line, but in another, drawn through the same Intersection, to a Point

the axis of the right eye only? Or will it be in the axis of the left eye only? But since the two holes appear as one hole to both eyes at the same time, would it not be more plausible for this single appearance to be situated along the axes of both eyes? But if we accept this alternative, we cannot say that the two holes are perceived as single by the two eyes because they are perceived in one line of direction only. Indeed, according to this alternative, the two holes would have to be perceived along two distinct lines of visual direction: the left hole will appear in one line of direction drawn from the left eye, and the right hole in another line of direction drawn from the right eye. But we could still argue that the two holes appear as a single hole because they are seen by both eyes as if they were in the same place in space – as if they were 'projected' along the two lines of direction in one particular spot at a distance, the spot where these lines cross each other. Thus, if the two holes are seen in the axes of both eyes at the same time, it seems they can be perceived as a single hole, only if they are perceived as being located at the point of intersection of the two optic axes, where the object seen through the two holes is situated.

However – as Wells points out – this solution is contrary to fact, since the united hole does not appear to be located at the intersection of the optic axes but closer to viewer.[32] Although Wells does not raise this objection at this point, this solution also seems to presuppose that we originally perceive distance by sight, since in order to perceive the point of intersection of the two optic axes, we would have to perceive at which distance from each eye the axes cross each other.

According to Wells, Reid's theory tells us that the two objects in the axes of the eyes will be seen as single, but not in what unique line of direction this single appearance will be with regard to the eyes:

---

in the Visual Base distant half this Base from the similar Extremity of the former Line, towards the left, if the Object be seen by the Right Eye, but towards the right, if seen by the Left Eye'. For Wells' explanation of the three propositions, see Wells, *Essay upon Single Vision with Two Eyes*, 86–91 [40–55]. For an account of Wells' laws of visual direction, see Wade, *Destined for Distinguished Oblivion*, 127–30; Wade, Ono, Mapp, Lillakas, 'The Singular Vision of William Charles Wells (1757–1817)', 3–7; Hiroshi Ono, 'On Wells' (1792) law of visual direction', *Perception & Psychophysics* 30 (1981), 403–6. See also, below, Appendix III.

[32] Wells, *Essay upon Single Vision with Two Eyes*, 86 [41]: 'But whoever makes this experiment will distinctly perceive, that the united hole is much nearer to him than the object […].'

> The other explanation is that furnished by the theory of Dr. Reid. According to it, the centres of the retinas, which in this experiment receive the pictures of the holes, will, by an original property, represent but one. This theory, however, though it makes the two holes to appear one, does not determine where this one is to be seen. It cannot be seen in only one of the perpendiculars to the images upon the retinas, for no reason can be given why this law of visible direction, which Dr. Reid thinks established beyond dispute, if it operates at all, should not operate upon both eyes at the same time; and if it be seen by both eyes in such lines, it must appear where those lines cross each other, that is, in the same place with the object viewed through the holes, which, as I have already mentioned, is contrary to experience.[33]

Reid's theory of visual direction informs us that an object will be seen in the direction of a right line passing from the point of the retina where its image falls through the centre of the eye. Hence, the two objects in the axes of the eyes will be seen in two lines of visual direction: the object in the left axis will be seen in one line of visual direction drawn from the left eye, and the object in the right axis will be seen another line of visual direction drawn from the right eye. The single appearance of the two objects will not be seen in one line of direction only. But if we accept Wells' claim that we see an object as single with two eyes if we see it in one line of direction only, it seems to follow that, in this case, we will have to see double. But we do see the two objects as single when they are placed in the axes of our eyes.

Hence, we end up with this choice of alternatives: (1) either we give up the standard law of visual direction whenever we see objects single with two eyes, or (2) or we do not give up the standard law of visual direction when we see objects as single with two eyes.

The first alternative seems to make sense. One could say that the law of visual direction applies only to monocular vision, but not to single vision with two eyes. But a consequence of this claim would be that an object is seen in one direction with one eye, and in another direction with both our eyes, and this is contrary to experience.

> Nor is [the apparently single hole] seen in any direction, the consequence of a law affecting both eyes considered as one organ, but suspended

[33] Ibid., 86 [41–42].

> when each eye is used separately. For when the two holes appear one, if we pay attention to its situation and then close one eye, the truly single hole will be seen by the eye remaining open, in exactly the same direction as the apparently single hole was by both eyes.[34]

If we do not give up the standard law of visual direction, then we see the two objects placed in the optic axes in two lines of visual direction from the two eyes. As Wells argues, whatever original property of the eyes makes us see the two objects as single must also make us see this single appearance in both these directions at the same time. Hence, we must see them as united at the point of intersection of these lines of direction, where the optic axes meet. But if we see them at the point of intersection of the optic axes, we must be able to perceive immediately distance from each eye. This consequence, however, is contrary to a fundamental claim of Reid's theory of vision. Following in the footsteps of Berkeley and Robert Smith, Reid holds that the visual perception of distance is not original but acquired. We do not originally perceive distance by sight, but learn to associate certain clues that accompany vision with the original perception of distance given by the sense of feeling.[35] In a previous passage of the *Essay*, Wells neatly summarizes this objection to Reid's theory of single vision:

> Since visible place [...] includes in it visible distance, it is evident that, if both eyes, by virtue of an original property, see an object in the same place, distance must also be originally perceivable by sight. Dr. Reid however, has himself so ably shown, that we should never have acquired by means of our eyes, any knowledge of distance, unless they had been assisted by the sense of feeling, that I forbear to say anything more upon this head, than the existence of no property can be admitted, which leads to the conclusion I have stated.[36]

---

[34] Ibid., 86–7 [42].

[35] On Reid's theory about the visual perception of distance, see Reid, *Inquiry*, VI.22, 178–87. In his Aberdeen lectures on natural philosophy given in the session beginning in 1757 (Aberdeen University Library, MS K160, proposition XXXIV, 300 et seq.), Reid subscribed to William Porterfield's theory of single and double vision. This theory does indeed presuppose that we originally perceive distance by sight. In the *Inquiry*, Reid rejected Porterfield's theory (see Reid, *Inquiry* VI.18, 156–9).

[36] Wells, *Essay upon Single Vision with Two Eyes*, 82 [27].

Conclusion

What is the upshot of our discussion of Wells' critique of Reid? First, according to Wells, Reid's theory of single vision, by itself, is incomplete, because it fails to specify one unique line of direction with regard to our eyes in which we see an object as single. If Reid does not specify one single direction in which we see the object, then we would have to see two fingery objects even when, as a matter of fact, we see our finger as single using our eyes. We should see two fingery objects because we see the same object from two points of view in two lines of visual direction.

Secondly, if Reid wants to maintain that the law of single and double vision is compatible with his law of visual direction, he must give up the claim that we do not originally perceive distance by sight.

As was shown in the first part of this paper, appearances in double vision could be understood as visible figures of an object. It has also been suggested, against Van Cleve's thesis, that the notion of visible figure does not threaten Reid's direct realism. Reid's law of monocular visual direction states that we see an object in a particular direction, and this direction, in normal circumstances, coincides with the position of an object with regard to the eye. As we have seen, this notion of position with regard to the eye is part of Reid's definition of visible figure. However, Wells' critique shows that Reid has failed to explain how the law of visual direction is compatible with the law of single and double vision.[37]

APPENDIX I

Wells' Arguments in Part I of the *Essay upon Single Vision with Two Eyes*

In Part I of the *Essay upon Single Vision with Two Eyes*, Wells' criticism of Reid comes after the critique of two theories. Firstly, Wells addresses the theory he ascribes to Aguilonious, Dechales and William Porterfield. According to Wells, these authors assert that all objects (whatever their distances from the eyes may be) appear in the plane of the horopter and that an object is seen as single if it is actually situated on this plane (the horopter is a plane parallel to

[37] I would like to thank John P. Wright for comments on the paper, and Hiroshi Ono for bibliographic references. Quotations from Reid's manuscripts are printed with permission of Special Collections, Aberdeen University Library.

our eyes and passing through the object on which our eyes converge). Wells also criticizes Robert Smith's account, according to which we see objects as single by learning to associate the two appearances originally given by the eyes with the information given by feeling that the object is single. Wells then presents a series of remarks on Reid. He firstly objects to Reid on anatomical grounds: according to Wells, Reid was wrong on the anatomy of the eye, and so his notions of optic axis and centre of the retina are not based on fact (see Appendix II, for Reid's remarks on this part of Wells' critique). Secondly, Reid's law of single and double vision goes against 'the analogy of nature': whenever we find symmetrical organs or parts in our body (organs or parts placed in a symmetrical position with regard to an axis dividing our body into a left half and a right half), the right external part corresponds in its function to the left external part, and the right internal part corresponds in its function to the left internal part. But Reid's law of single vision holds that points of the right eye's retina that are on the left side of the centre of the retina (and so on the internal side of the right eye's retina) must correspond to points of left eye's retina that are on the left side of the centre (points that are on the external side of the left eye's retina). To these 'apriori' criticisms, Wells adds three objections. The first objection states that since visible place includes visible distance in its notion, and objects are seen single if they are seen in the same visible place, the original property that makes us see objects as single should also make us see the distance at which objects are located. However, according to Reid, distance is not originally perceived by sight. The second objection cryptically alludes to the incompatibility between the law of visual direction and the law of single and double vision. According to the law of visual direction, we see every point of an object in the direction of a line passing from its picture on the retina through the centre of the eye. It seems to follow from this law that we see an object to which we direct our eyes as double, since we see it in one line of direction from one eye, and in another line of direction from the other eye. On its part, the law of single and double vision specifies on which occasions we see an object as single and on which occasions we see it as double. If the two laws are different, and work together, a paradoxical result follows: '… should the two laws exist together [without being the same identical law], objects seen with both eyes might sometimes appear quadruple, sometimes, triple, but never single'.[38] The third objection points outs that two objects – one placed in the axis of

[38] Wells, *Essay upon Single Vision with Two Eyes*, 82 [28].

the right eye of a squinting person, the other in the axis of the left eye of the same person – are not seen as single (contrary to what Reid's theory of single vision predicts in normal cases).

APPENDIX II

Disagreements between Wells and Reid on the Anatomy of the Eye (MS 2131/3/I/4, June 1792).

Wells first objected to Reid's theory of single and double vision on anatomical grounds. Interestingly, Reid, in his brief manuscript remarks on Wells' book, devotes most space to correct Wells' anatomical descriptions.[39]

According to Wells, the corresponding points of the two retinas, that

[39] See Aberdeen University Library, Birkwood Collection, MS 2131/3/I/4. The manuscript is dated: "June 1792 Read an Essay upon Single Vision with two Eyes by Will. Ch. Wells M.D. 1792." In his notes on Wells, Reid first reports Aguilonius' and Porterfield's accounts of the horopter (see Wells, *Essay upon Single Vision with Two Eyes*, 75 [4]). Reid also incidentally chastises Wells for having said that Porterfield merely copied Aguilonius: 'Dr. Porterfield (who this Author without good reason says has done little more than copy Aguilonius) I think makes what he calls the Horopter to be everywhere at the same distance from the Eyes, as the intersection of the optic axes'. After briefly mentioning Wells' account of Robert Smith's observations on the location where single and double appearances are seen (the original edition of Wells' *Essay*, 14), Reid concentrates on Wells' anatomical remarks (Wells, *Essay*, 80–81 [22–23]). These observations are followed by an important but undeveloped short remark on Wells' theory: '44: He takes it for granted that when two objects are seen as one, they must be seen in a certain place, that is at a certain distance as well as in a certain direction'. Reid then reports Wells' first two laws of single and double vision: '43 His first Prop. is that Objects situated in the optic Axis do not appear to be in that line but in the common Axis. 2 Prop. Objects situated in the Common Axis do not appear to be in that line, but in the Axis of the Eye by which they are not seen'. At the end of the manuscript, Reid reports the observations made by Wells on the appearance of a line perpendicular to the horizon and on the single appearance of an afterimage (Wells, *Essay*, 92 [61] and 94 [66]). Reid's manuscript notes on Wells amount to no more than one page and a half. They are overall disappointing, since they concentrate on anatomical matters and fail to address Wells' main criticism. That Reid did not realize the importance of Wells' contribution is further confirmed by a passing comment he made in a letter to Dugald Stewart (21 January 1793): "I return with this Wells' book on Vision, which has much learning on the subject, and therefore may be fit to answer the purpose of one who sets up as a physician in London; but I do not see that it makes any addition to human knowledge" (*The Correspondence of Thomas Reid*, edited by Paul Wood [Edinburgh, 2002], letter 122, 231).

is, the points of the two retinas that make objects appear single cannot be the centres (middle points) of the retinas, and points similarly situated with respect to them. Indeed, the pupil and crystalline are situated towards the nose in relation to the centre of the globe of the eye, which includes the cornea, the iris, and the retina. Hence, the optic axis of an eye – the right line that passes through the centre of the globe of the eye, the middle point of the cornea and the middle point of the retina – will be situated on the outer side of the straight line passing through the middle point of the pupil and the centre of crystalline. As a consequence of this fact, the central ray of light that enters the pupil does not lie in a right line that coincides with the optic axis of the eye. Contrary to what Reid said, the two images of a point will never fall on the anatomical centres (or middle points) of the retinas.

According to Reid, Wells erroneously took for granted that optic writers called 'axis of the eye' the line that passes through the middle of the cornea and the centre of the globe of the eye rather than the line that passes through the centre of crystalline. Moreover, according to Reid, Wells erroneously took for granted that what other optics writers called centre (or middle point) of the retina was the point of the retina cut by a right line drawn through the middle of the cornea and the centre of the eye.

Wells also remarked that the curvature of the cornea does not have the centre of the crystalline as its centre: as a consequence, no rays of light pass unbent from the atmosphere to the retina. Reid replied that 'the curvature of the cornea seems to have the centre of the crystalline for its centre' (although the 'middle of the cornea [...] must pass on the outer side of the centre of the crystalline'). Hence, contrary to what Wells claims, the central ray of light coming from the object passes unbent from the atmosphere to the retina.

It is clear that Reid ascribed some importance to the anatomic description of the structure of the eye. It is also possible that his remarks might require a slight reformulation of the law of visual direction: we should say that we see an object in the direction of a right line passing through the centre of the crystalline instead of one passing through the centre of the eye.

APPENDIX III

Wells' Three Propositions on Single Vision.

1. Objects situated in the optic axis, do not appear to be in that line, but in the common axis.

2. Objects, situated in the common axis, do not appear to be in that line, but in the axis of the eye, by which they are not seen.

3. Objects, situated in any line drawn through the mutual intersection of the optic axes to the visual base, do not appear to be in that line, but in another, drawn through the same intersection, to a point in the visual base distant half this base from the similar extremity of the former line, towards the left, if the objects be seen by the right eye, but towards the right, if seen by the left eye.

I include two figures, taken from Hiroshi Ono's article, which will facilitate the understanding of Wells' propositions.[40] The first figure clarifies the terminology used by Wells, and illustrates the first proposition. Objects situated in the optic axes do not appear on those lines, but in the common axis. Thus, the tree, situated on the axis of the right eye, and the house, situated on the axis of the left eye, both appear to the eyes as lying on the common axis.
The second figure well illustrates Wells' propositions 1 and 2. According to proposition 1, the two round holes, situated in the axes of the two eyes, will appear as a round single hole in the common axis. According to proposition 2, the square hole, situated in the common axis, will appear as two square holes situated along the axes of both eyes. As Ono says, the two outside circular holes are predicted by proposition 3.

[40] See Ono, 'On Wells's (1792) law of visual direction', 403–4. Figures are reprinted with permission of the publisher, Springer Science+Business Media.

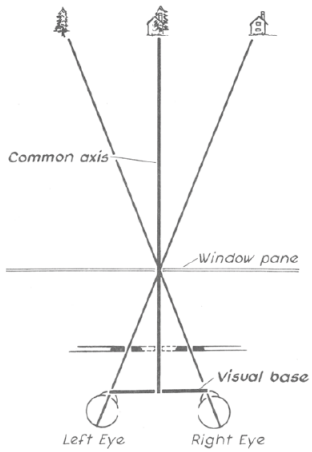

Fig. 1

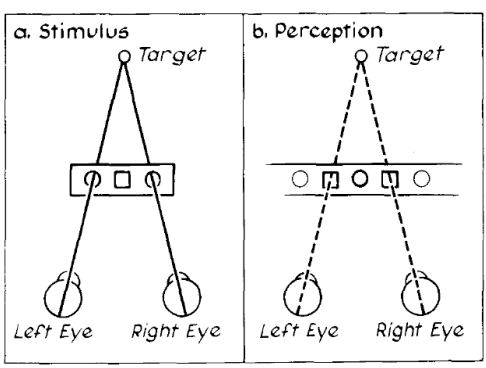

Fig. 2

University of British Columbia Okanagan